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ABSTRACT

This paper describes a study in which a Picture Readability Index (PRI) was used to investigate initial and extended perceptions of photographs. Readability criteria for evaluating instructional text seems to have been in place for a long time, yet instructional visuals like photographs and illustrations have typically been subject to no such criteria. The PRI, developed from research in the areas of semiotics, linguistics, perception, visual literacy, and cognitive psychology, seeks to apply measurable readability criteria to these visuals. It considers first impressions gained from brief exposure, and also examines how a picture and caption are processed together during prolonged exposure. Data is coded and entered onto a nomograph for comparison between affective and cognitive domain classifications. The paper-and-pencil version of the PRI test, that was administered to a small group of students, however, is somewhat limited by its length and complexity, which may cause fatigue to have an influence on responses. Thus researchers set out to adapt the PRI test for the computer; besides eliminating the fatigue factor, the computer-assisted version would also organize data and simplify the process of projecting the image for viewing by the respondent. Adapting the PRI test into a computer-administered format involved selecting an authoring tool, flowcharting to modularize the instrument, storyboarding, scanning in photographs and drawings, creating test questions, and constructing and revising the multimedia prototype. Future study may include a computerized-adaptive version of the PRI, in which the progression of questions on the monitor will depend on prior responses. (Contains 27 references.) (BEW)

Adaptation Of A Visual Readability Instrument To Multimedia Format

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Abstract

The Picture Readability Index (PRI) used in this study is a qualitative instrument that was based on research and theory from the areas of semiotics, linguistics, perception, visual literacy and cognitive psychology. It investigates the initial and prolonged stages in the perception of photographs according to the comparison of affective and cognitive domain classifications on a nomograph format. The two major limitations of this instrument were complexity and length. Administering the PRI via computer simplifies the data gathering process and enables easy administration to larger groups.

Visual Information Processing and the PRI

Visual information processing consists of a first glance, and a second more extended phase. The first glance is fast, less conscious, and works with a smaller amount of information. The second more extended phase is more conscious, takes more time, works with more information and details, and demands more attention (Spoehr & Lehmkuhle, 1982).

Winn (1993) referred to these two phases of perception as the "basic mechanisms" of "preattentive" and "attentive" processing (p. 57). The perceptual organization of visual information takes place during the preattentive processing. Attentive processing is a very selective mechanism which uses "attentive selection and those cognitive processes that further organize perceived information in preparation for its assimilation to existing schemata in memory" (p.58). For the development of the PRI the two phases of perception were incorporated in the process.

Readability of Visuals

Myatt and Carter (1979) found that children and adults prefer realistic photographs first, and realistic drawings second. Photographs are usually perceived as realistic and their credibility is rarely questioned. Instructional guidelines are not the only factors involved in the development of instructional visuals. Cost, marketing, attractiveness and the "subjective feelings of the designer" also play a significant role in the process of their production (Dwyer, 1972, p. 2). Textbook adoption decisions benefit from specific subject matter and pedagogical knowledge that are used to examine the reading level of text. Visuals are rarely examined in detail because there aren't any established criteria that could be used in evaluating their readability level.

Publishers widely use text readability principles which are based on comprehension and vocabulary difficulty and readability (Chall & Conard, 1990). Readability, as a criterion for judging textual content of textbooks, has been a major component of textbook evaluations and adoption decisions for more than seventy years. Photographs and

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illustrations have not enjoyed the availability of a similar instrument. A variety of general purpose media selection models have been based on expert opinion and principles that derived from several research studies and experiments (Romiszowski, 1988; Dwyer, 1972; Fleming, 1967). An early example of such guidelines for the selection of visuals for instructional purposes, as stated by Hoban (1937), were "truth..., photographic quality..., relevancy..., relative size of items..., and mechanical qualities..."(p. 160).

The Program of Systematic Evaluation, initiated by Dwyer in 1965 at Penn State University, was one of the early attempts to identify a set of criteria that would be used to select the appropriate visuals for certain types of educational objectives (Dwyer, 1994, p. 391). The guidelines deriving from visual research were not aimed to create precise prescriptions for effective visualization for all the learners. Instead, these guidelines were aimed to make sure that the majority of the students would benefit from a specific set of visuals. As Dwyer (1994) put it "these guidelines would possess the highest degree of predictability for the design and use of visualization, to ensure that a majority of learners, for whom the instruction was designed, would receive the intended message" (p. 385).

Goldsmith (1987) contrived a method of describing illustrations that encompasses both visible and invisible elements. Goldsmith's analytical model was mainly directed towards the comprehensibility of the illustrations. This model consisted of 12 elements. Four visual factors (unity, location, emphasis, text parallels) and three levels of communication (syntactic, semantic, pragmatic) were interrelated to create a matrix consisting of the 12 elements (p. 54-55).

Pettersson (1993) was the first to propose and develop a Picture Readability Index (BLIX) which was based on nineteen variables of the visual language. In experiments with ranking and rating test pictures he found that those pictures that had high index-values were rated higher than pictures with low index-values by both adults and children. According to Pettersson (1993), BLIX "represents the average difficulty or ease with which a picture can be read"(p. 158).

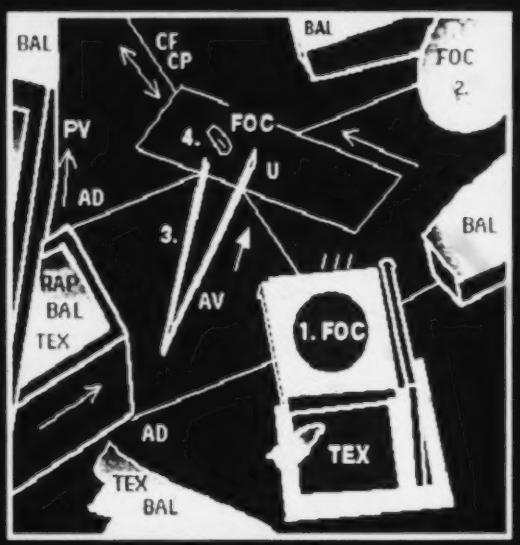
Photograph Readability Index

Attempts to measure the readability of instructional visuals employ principles from the fields of semiotics and linguistics. Visual semiotics principles are used to examine the codes used in visual languages. In a recent approach towards visual semiotics, Saint Martin (1990) linked semiotics with the gestalt theory of perception. In order to study the grammar of a visual language, it is essential that the basic elements of the language be identified. Then, semiotical analysis is applied that prolongs the first phase of perception towards two different levels. During the first level it examines the basic units of visual language. In the second level it examines the interaction, regroupings and dynamic tensions between the visual variables and how they group in order to communicate the message they were designed for. This approach derived from the verbal grammar which pays attention to the individual elements that make up a language (verbs, nouns, etc.), as well as to the syntactic laws according to which these elements are organized to convey meaning.

The PRI examines the initial and prolonged stages in the perception of photographs according to the comparison of affective and cognitive domains. The first part of the PRI investigates how individuals process information at a first glance. The second part examines how a photograph and its caption are processed together. Conventional text readability formulae have become methods of recording expert judgment regarding textbook adoption. They were designed to be used in conjunction with other measures. Adaptation of this concept to

Figure 1
PICTURE WHICH IS THE BASIS OF ANALYSIS IN FIGURE 2

Figure 2
VISUAL SYNTAX NOTATIONS OF VIEWER PERCEPTION



VISUAL SYNTAX KEY OF FIGURE 2

AD - Active diagonal
AV - Active vertical
BAL - Balancing form
CF - Centrifugal
CP - Centripetal
FOC - Focal point of composition
PV - Passive vertical or minor vertical element
TEX - Texture
1, 2, 3,... - Perceptual order of major focal points
RAP - Repeating pattern

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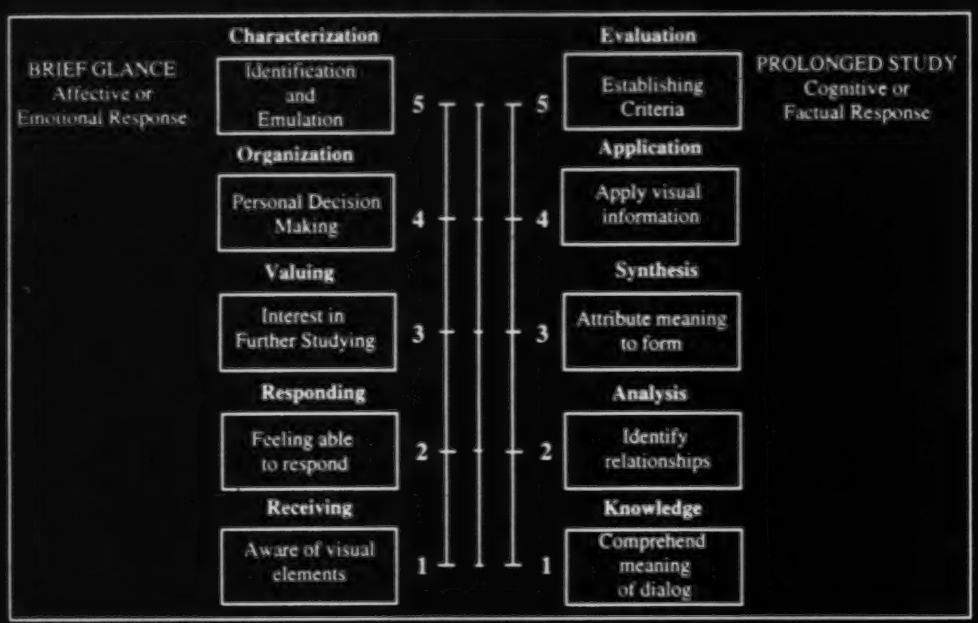
Figure 3
THE AFFECTIVE & COGNITIVE DOMAIN LEVELS ON A NOMOGRAPH FORMAT



visual media is a logical extension of the visual grammar analogy suggested by Saint-Martin (1990). An example of a simple notation system used to define the visual syntax found in images is illustrated in Figures 1 and 2.

The PRI uses the levels of the cognitive and affective domains to structure questioning. The scores from the questionnaire indicate the level students have reached on the domains. Zakaluk and Samuel's (1988) two factor reading comprehensibility nomograph was adapted to accept short duration (affective) and prolonged duration (cognitive) classifications of data. The nomograph used for entering the data is shown in Figure 3.

The specific procedures of interrelating the affective and cognitive scores into one rating was suggested by Krathwohl, Bloom, and Masia's (1964) description of the domains as "analogous to a man scaling a wall using two step ladders side by side, each with rungs too wide apart to be conventionally reached in a single step... the attainment of some complex goal is made possible by alternatively climbing a rung on one ladder which brings the next rung of the other ladder within reach " (p. 60). This analogy illustrates the one sided or one ladder nature of much evaluation literature (Lantz, 1992). The comparison of the affective and cognitive domains in text readability formulae suggested the use of the nomograph.

For the first phase the image is flashed for 1/2 a second. From earlier experiments it was found that 1/2 a second is an average of the time necessary to perceive basic gestalts (Sperling, 1960). Short duration questionnaire items were written for each level of Krathwohl's et al (1964) affective domain. For the second phase the photograph and its caption were provided for consultation during the completion of the cognitive questionnaire. Cognitive items were written for each level of Fleming's (1967) adaptation of Bloom's

(1956) cognitive domain.

Outline of the PRI

The PRI consists of Phase I, Phase II, and the data coding procedure:

Phase I - Brief Duration

(1) Brief display of the photograph, (2) viewer directed to draw major elements, (3) affective questioning, and (4) coding of responses to domain.

Phase II - Extended Duration

(1) Prolonged exposure to photo and caption, (2) cognitive questioning, (3) coding of responses to domain, and (4) for visual data presentation the viewer drawing from phase I is labeled with the relationships between forms established in the phase II of the questionnaire.

Data Coding

(1) Enter coded data on nomograph, (2) determine the readability index by drawing a line between the affective and cognitive axis, and (3) present results of a pilot to a panel of adoption experts (Lantz, 1992, p.56).

Viewer reactions during the first phase of perception are often mainly affective oriented. Subsequent more prolonged study of an image can be primarily cognitive oriented. First responses to an image usually determine the viewer's willingness to further study the image. Therefore, affective and cognitive responses to images are interrelated. Affective responses usually determine the extent to which a cognitive response will follow and to what depth it will be processed. This is why the affective and cognitive domains are compared on a nomograph.

Validity, Reliability and Limitations of the PRI

The PRI used in this study was pilot tested by Lantz (1992). Because of its length, it was only administered to a small group of students. It needs to be further tested and revised. Administering the PRI to larger groups of students over a network from individual computer terminals and testing it over time, can lead to the establishing of a certain degree of validity and reliability.

The questionnaire items of the PRI were based on the affective and cognitive domains. The structure of the domains carried certain limitations. Krathwohl et al (1964) were aware of these possible limitations and were reluctant to publish the affective domain because it was regarded speculative in comparison to Bloom's cognitive domain: "we present it with some trepidation and full expectation of severe criticisms from many quarters" (p.14).

Bloom (1956) suggested that one of the major potential limitations to the cognitive domain was the level of generality which should be set "where the loss by fragmentation would not be too great" (p. 6). For visual material the risk of fragmentation is potentially higher than for textual material. Visual images often contain a far greater variety of potential interpretations than text. Adapting the cognitive domain for photographic material might be overstructuring or limiting the potential for expression (Lantz, 1992).

Images with low readability values should not be considered inferior to images with high readability values. Pettersson (1993) postulated that the Picture Readability Index "must not be an end in itself. There is always a risk associated with index values, since they can be interpreted as absolute values" (p. 158). Judgments regarding visuals should only be made within the proposed context the image is to be used. If the purpose of an image is to promote different responses and ways of interpretation then one with a low readability value would be better than an image with a high readability value. The readability rating deriving from the PRI should be thought of as a classification attempt and not a value judgment.

The results of an expert panel discussions and evaluation of the complete instrument suggested that most of the elements of the instrument were important (Lantz, 1992). Most of the data generated was considered "necessary" for the distinction of one group of images over another. The two major limitations of the PRI were complexity and length. The paper-and-pencil version of the PRI was too extensive to be applied to large populations and for applications with limited time restraints. The length could be made more manageable if all the components were shortened based on the common objectives of the instructional images for particular applications.

Saint Martin (1990) postulated that "the abundance and the variability of data in the visual language may require the instrumentation of the computer" (p. 187). Adaptation of the PRI into a computer-administered format has the potential of overcoming the major problems identified by the expert panel. In order to address the problems surrounding the PRI an authoring software was used which enabled the adaptation of the instrument into a multimedia format and the creation of a computer administered version. This computer administered version simplified the data gathering process and enabled easy administration to larger populations over a network.

Computer-Based Testing

In many testing situations questionnaire items can be too easy or too difficult for some students. Testing time is often a problem in a traditional paper-and-pencil test. When the test is too long and the students are asked to respond to all of the items, fatigue may influence their responses.

Olsen, Maynes, Slawson, and Ho (1989) conducted a study to compare the achievement scores of students who were tested via three testing methods: paper-administered testing, computer-administered testing, and computerized adaptive testing. In the computerized adaptive testing, each testing item was determined by the students responses to previous items. It was found that the computer-administered testing method required one half to three quarters of the testing time required by the paper-administered test. The computerized adaptive method required only one fourth of the testing time required by the paper-administered method. Also, the computerized adaptive method, provided "a more precise ability estimate with smaller variance" than the other two testing methods (p. 322).

Other studies (Luntz & Bergstrom, 1994; Olsen, 1990; Welch & Frick, 1993; Legg & Buhr, 1992) indicated that computer-based tests resulted in reduction of testing time and maintained precision. In addition to the reduction of testing time, researchers found high correlations between paper-and-pencil and computerized adaptive tests (Olsen, 1990; Koch, Dodd, & Fitzpatrick, 1990). Federico (1991) found that computer-based methods and paper-based methods "were not significantly different in reliability or internal consistency" (p. 345).

Advantages of the Computer-Administered PRI

There are many advantages associated with the use of a computer to administer an instrument. In this study some of the advantages deriving from the development of the computer-administered PRI were: (1) reduction of testing time, (2) as a consequence of the reduction of testing time is the reduction of the fatigue effect, (3) records and precise times are automatically stored by the computer; therefore, the management and organization of data is simplified, (4) the computer-administered version allows individualized testing and also enables easy administration of the instrument to large groups over a network, and (5) the projection of the image on the computer monitor is made easier. There is no need for preparing a room (ensure complete darkness, distance from screen, shutter to flash the

image for .5 seconds, etc.).

Differences Between the Paper-and-Pencil and the Computer-Administered PRI

The differences between the two versions of the instrument are: (a) In the paper-and-pencil version the image is presented on a big screen during Phase I, and in print during Phase II. In the computer-administered version the image is presented on the computer monitor during both phases, (b) on the computer-administered version the students are not allowed to review their responses and make changes, (c) the quality of the photograph on the computer monitor might influence the responses to the questionnaire, (d) on the paper-and-pencil questionnaire the students can go through all of the questions at a glance; whereas on the computer-administered version they go through one item at a time, and (e) the response on the paper-and-pencil is made by marking the answer with a pencil. In the computer-administered version they respond by clicking the mouse or pressing a key which makes the responding easier (Federico, 1991; Green, 1988).

Limitations Deriving From the Adaptation of the PRI:

Although many studies found a strong correlation between paper-and-pencil tests and their equivalent computer-administered tests, it can not be assumed that any paper-and-pencil test is equivalent to its computer-administered version. Only when research has provided results that justify the equivalence of the two versions, should the two versions of the test be regarded as equivalent. Therefore, until studies had provided the results that justify equivalence, the results of the computer-administered version should be dealt with discretion (Dimock & Cormier, 1991, p.125).

There are certain limitations associated with the adaptation of the PRI into a multimedia format. The photograph presented on the computer screen is different in format than the photograph in the textbook. Therefore, student evaluators could be influenced by the format of the photograph (digital versus print) and respond differently. Also, proximity to the image is different in the two versions of the PRI because in the computer-administered version the image is flashed on individual monitors. The student evaluators are in very close distance to the monitor. Therefore, they would probably pay more attention to the computer than to the projected image in a big screen, which may influence their responses. Another factor that may influence response is computer anxiety. Computer experience among the students that will participate may influence the study results. Students with more computer experience may respond differently than students with less or no experience.

Procedure Followed for Adapting the PRI

The steps that were followed for adapting the PRI into a computer-administered format are listed below.

(1) Firstly, the authors selected the appropriate authoring tool. For the development of the computer-administered version of the PRI Authorware Professional was used. Some of the reasons that led to this choice were: it is an easy to use authoring tool, the authors were already familiar with it, and it can keep track of users responses including names, time, and answers to individual question items.

(2) Then, a flowchart was created that assisted in modularizing the instrument.

(3) After the flowchart, the authors created detailed storyboards illustrating the textual and visual information that would be included in every display as well as navigation options that would be provided to the student evaluators.

(4) All the photographs and drawings that were used were scanned and retouched in Adobe Photoshop.

(5) Then, a model with the multiple choice questions and the assigned variables necessary to store the answers was created.

(6) Once all the materials were ready, the construction of the prototype followed. The prototype was tested to ensure that it reliably stored the user's responses to all the individual items, as well as the time spent in every section.

(7) Lastly, the authors revised the prototype and produced the final cut of the computer-administered version of the PRI.

The next step would be to actually administer the two versions of the PRI to different groups. Only when research results suggest that the computer-administered PRI is equivalent to the paper-and-pencil version of the PRI, should the two versions be regarded as equivalent.

Conclusions

Educators and instructional designers often falsely assume that certain visuals will have the same impact on a group of learners. Cultural conditioning influences the way we read images. Learners from different cultural backgrounds and with different prior experiences, have different ways of responding to images (Pettersson, 1993; Mangan, 1978). Adoption committees and media developers do not have the benefits of an organized and established body of criteria for the selection of instructional images. The PRI was based on research which can provide suitable structure and design for establishing such criteria.

A possible future study would be to construct a computerized-adaptive version of the PRI. In such an instrument subsequent question items that will be presented on the monitor will depend on the viewers prior responses. When a viewer has achieved a level, she or he will jump to the next level without having to respond to all of the items. Such an instrument has potential of reducing the time needed to complete the PRI questionnaire.

Similar approaches and methods employed in the development of the PRI could be used to develop an instrument that could be used as a diagnostic tool by instructors of classes that use often visual media. The readability of images would not be addressed but rather the development stage and the visual literacy skills of the learners would be identified. Therefore, art, photography, and graphic design instructors might be able to use such a diagnostic tool to tailor instruction according to individual learner characteristics.

Adaptation of the PRI into a multimedia format was an exploratory study. A computer-administered PRI enables administration to larger groups over a network and simplifies the data gathering process. Further testing of the instrument by administering to larger groups can establish a certain degree of validity.

Attempts to measure the readability of instructional materials has certain limitations. As there are many different verbal languages, there are many visual languages as well. The PRI was not designed to be used in measuring the readability of all visuals. The instrument was designed to be used to explain the relationship between a particular set of illustrations and learners. Readability values should only be treated as a classification attempt with regards to a set of certain photographic and learner characteristics.

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